

Vegetation Monitoring Protocol for Klamath Network Parks

Standard Operating Procedure (SOP) #7: Live and Dead Tree Sampling

Version 1.00

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This SOP describes overstory sampling for live trees ≥ 15 cm DBH (diameter at breast height) or standing dead trees ≥ 15 cm DBH and 1.4 m or taller, and canopy cover in the 0.1 ha site. All measurements from this SOP are recorded in the Live and Dead Tree Sampling Database on the Tablet PC, and the sampling card shown at the end of the SOP (Figure 8).

Tree Tagging

All trees alive and dead ≥ 15 cm DBH will be tagged at breast height 1.4m (4.5 ft), with the stamped number facing away from the trunk and towards plot center (SOP #4: Site Locations, Set-up, Monumentation, and Description). Nail tags to trees, leaving 1-2 inches of nail exposed, to account for diameter growth. Trees that were likely numbered in the past (large size, much larger than 15 cm DBH) but are missing tags need to be retagged with the same number (if possible) using the previous datasheet and the surrounding trees to determine the tree number. In the notes section, record that the tree was retagged. If the plot occurs in an old-growth stand (defined as >4 trees >75 cm dbh within 40m of plot center) we will implement extend plot sampling. The extended plot (Figure 1) is not monumented but trees >75 cm dbh are tagged. And all other overstory sampling procedures (listed below) are executed.

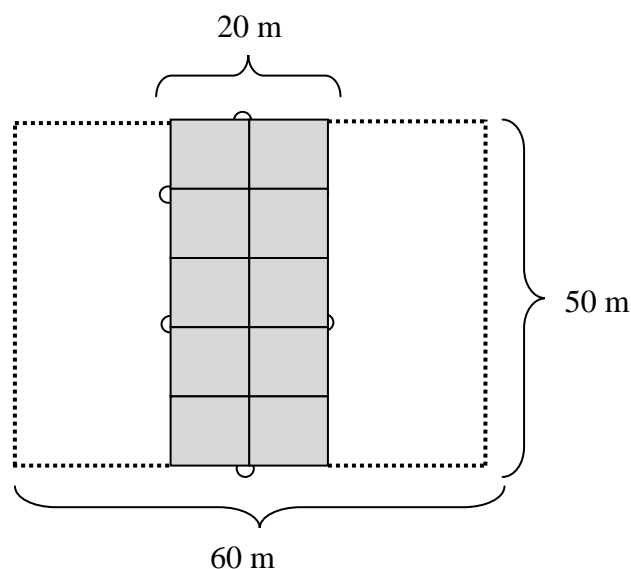


Figure 1. Diagram of extended sampling plot when in old growth stand. Dashed lines represent expansion of standard 20 x 50 m plot.

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Overstory Sampling

All live trees ≥ 15 cm DBH are measured or assessed for 1. DBH, 2. Canopy position and crown condition, 3. Height of the largest tree in each module (10 total), and 4. Height to crown. Sampling will be done for each 100 m² module separately. This sampling is best done by a two-person team. One person will measure DBH and assist in identification of the tree species. The other will determine its condition (crown dieback), height to crown, canopy position, crown cover, and record all data. The following procedures will be used:

Diameter at Breast Height

Diameter is measured at 1.4 m (4.5 feet) above the ground surface. The FIA and FMH field manuals have detailed instructions for how to measure DBH under the wide variety of situations that arise in the field. Use the breast height tree tag as a height guide for measuring DBH; if the nail and tag are missing, try to determine the tree number and replace the tag (see tree tagging). When measuring DBH, always make sure that the diameter tape is at a right angle to the lean of the tree (Figure 2). The observer must stand on the uphill side of the tree. With the Biltmore stick (only to be used if the tree cannot be measured with a DBH tape), two measurements are required: one on the uphill and one sidehill; these measurements are averaged and then recorded.

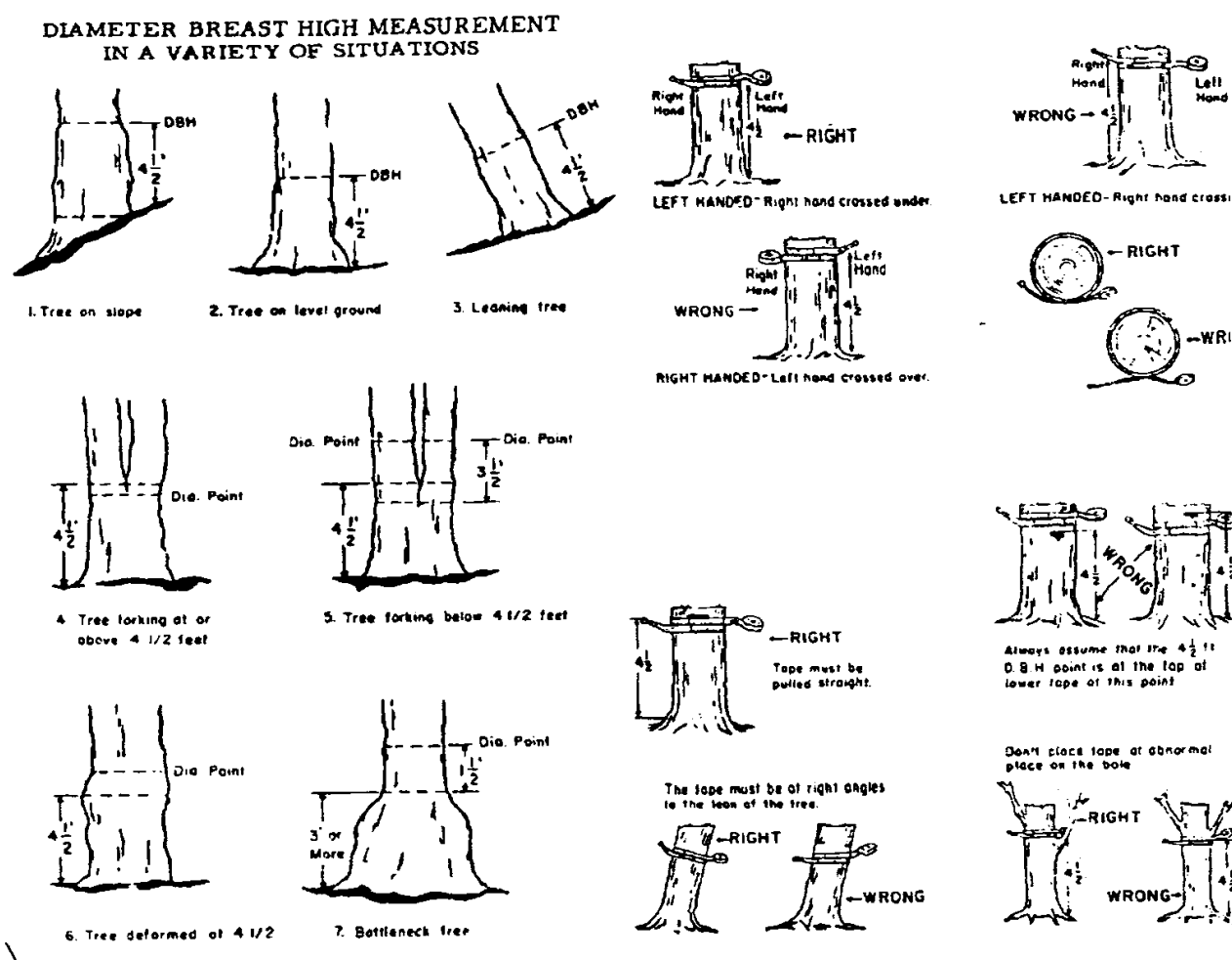


Figure 2. Correct placement of tape for DBH measurements. From the Great Smokey Mountains Vegetation protocol.

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Canopy Position and Crown Condition

1. After visual inspection, each overstory tree is assigned to one of five canopy position classes: 1 = dominant, 2 = codominant, 3 = intermediate, 4 = suppressed, or 5 = open grown. Descriptions of each class are provided in Table 1 and Figure 3.
2. After visual inspection, trees are assigned to one of six crown condition classes based upon percent crown dieback: 1 = No dieback; 2 = 1-25% dieback; 3 = 26-50% dieback; 4 = 51-75% dieback; 5 = >75 % dieback; and 6 = broken top. If the tree has 100% dieback, follow procedures below for characterizing standing dead trees (snags). Dieback is defined as percent of branches in the crown that are either dead or missing.

Table 1. Canopy position class descriptions. Canopy class primarily describes the amount of sunlight received. These canopy classes are consistent with those used by the US Forest Service's Forest Inventory and Analysis monitoring.

Class	Description
1	<i>Dominant</i> —trees with crowns extending above the overall level of crown cover and receiving full sunlight from above and partly from the sides. Trees are larger than the average overstory tree in the stand and have well-developed crowns. NOTE: A dominant tree is one which generally stands well above all other trees in its vicinity. However, there may be a young, vigorous tree nearby, but not overtopped by a dominant tree. This smaller tree may be considerably shorter than the dominant, but still be receiving full light from above and partly from the sides. In its own immediate environment, it is dominant and should be recorded as such. Only understory trees immediately adjacent to the overstory tree will be assigned subordinate crown classes.
2	<i>Codominant</i> —trees with crowns forming the general overstory-level canopy and receiving full light from above, but comparatively little from the sides.
3	<i>Intermediate</i> —trees shorter than those of the two preceding classes, but with crowns either below or extending into the crown cover formed by dominant and codominant trees. Trees receive little light from above and none from the sides. Trees may be located in single tree gaps that have closed-in from lateral growth of surrounding trees.
4	<i>Suppressed</i> —overtopped trees with crowns entirely below the general level of crown cover that receive no light from either above or from the sides.
5	<i>Open Grown</i> —trees grown in the open. The distance from these trees to the nearest tallest tree is greater than the height of the nearest tallest tree.

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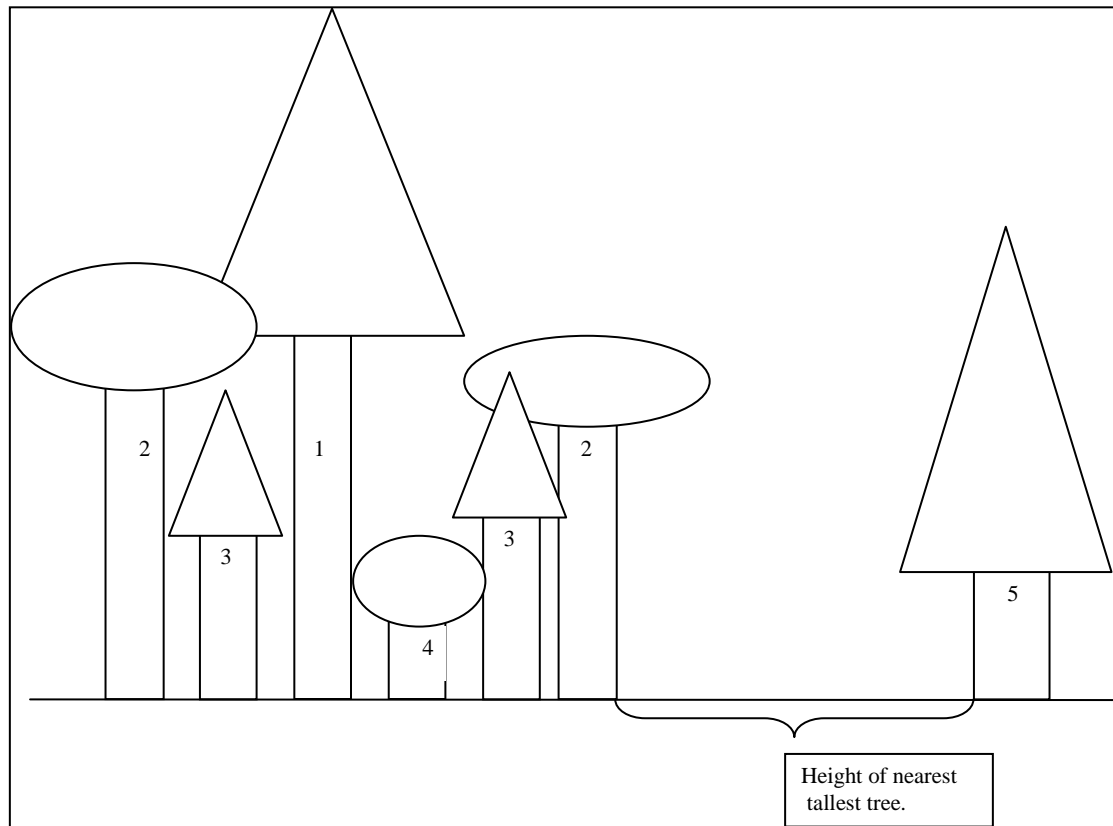


Figure 3. Diagram of the four canopy position classes (1 = dominant, 2 = codominant, 3 = intermediate, 4 = suppressed, and 5 = open grown). Depending upon stand history and developmental stage, all classes may not be present on a plot.

Tree Height (or Length)

Tree height will be recorded for the largest tree in each plot (10 total) and **all** whitebark pine and standing dead trees. A laser rangefinder will be used to measure height (SOP #3: Setting up the Electronic Equipment). Once on the HT setting, the first measure is HD the horizontal distance to the tree. Point the laser at the tree, making sure your view is unobstructed; push the fire button on the laser. The next measurement is INC 1: the angle to the base of the tree. Point the laser at the base of the tree and push the fire button. The next measurement is INC 2: the angle to the top of the tree. Point the laser at the top of the tree and push the fire button. All three of these measurements need to be taken from the same spot. Record the total height of the tree from the laser rangefinder, to the nearest 0.1 m. For trees growing on a slope, measure on the uphill side of the tree. Forked trees should be treated the same as unforked trees. For leaning trees, measure or estimate total normally-formed bole length (from the base to the tip of the tree). If the laser rangefinder is broken, a clinometer and tape can be used to measure tree height as described in Figure 4. However, this method is very time-consuming and should be recorded in the equipment log book.

Crown Base Height (Height to Compacted Crown)

Record the height to compacted crown for each live tree ≥ 15 cm DBH to the nearest 0.5 m or 10 percent. A laser rangefinder will be used to measure height. Compacted crown is the portion of the tree supporting live foliage (or in the case of extreme *temporary* defoliation, should be supporting live foliage).

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Compacted crown is foliage sufficiently dense enough to propagate fire. It is important to exclude isolated or sparse foliage below the compacted crown to avoid underestimating crown base height for fire behavior modeling. This modeling is based on live foliage. Therefore, an error term is introduced if twigs, dead branches, lichens, and other non-foliage are considered in the estimation of canopy base height. The base height of compacted crown is the lowest height of continuous foliage.

To determine height to compacted crown, mentally transfer lower live branches to fill in large holes in the upper portion of the tree until a full, even crown is visualized. *Try to picture the normal density of foliage that is not shade suppressed and adjust for it (i.e., some branches may be very sparse with needles/leaves).* Do not over-compact trees beyond their typical full crown situation. For example, if tree branches tend to average 1 m between whorls, do not compact crowns any tighter than the 1 m spacing. *Include epicormic branches once they are 3 cm in diameter.* Measure from the ground to the point you determine to be the bottom of the compacted crown. See above section (Tree Height) for use of the laser rangefinder and clinometers.

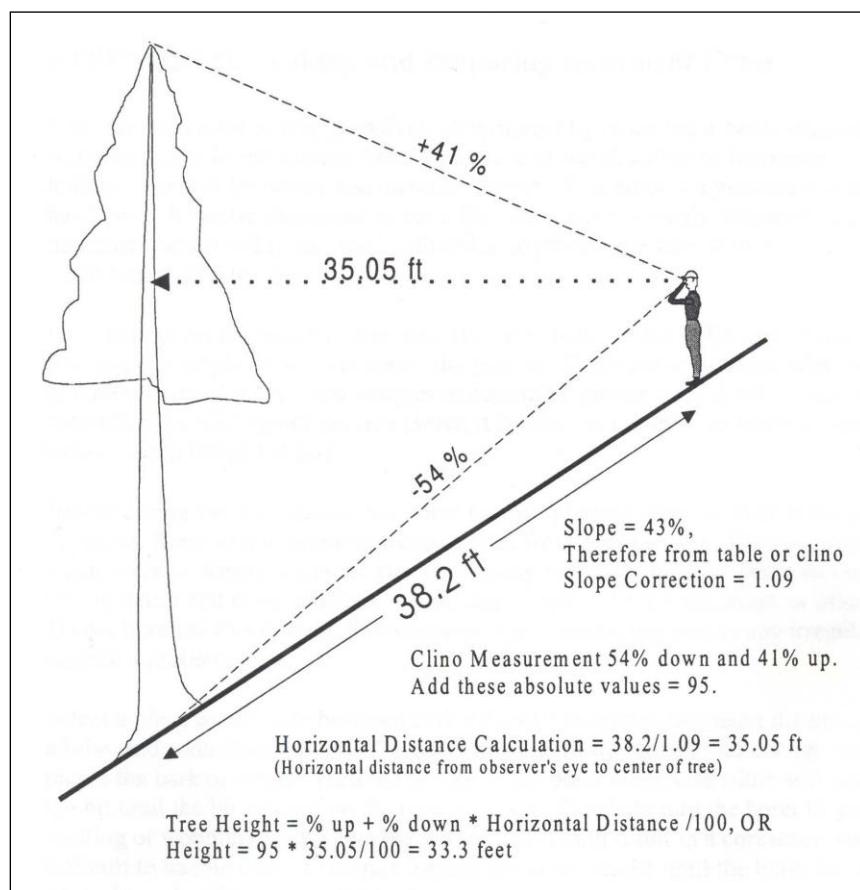


Figure 4. Finding tree height using a clinometer and tape measure.

Standing Dead Trees

1. Measure the DBH and height of all standing dead trees ≥ 15 cm DBH unless they have more than 45 degrees of lean from vertical, as measured from the base of the tree to 1.4 m (4.5 feet). Trees supported by other trees or by their own branches that meet these

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requirements are considered standing. This includes broken tree tops stuck in the ground.

Trees do not have to be self-supporting. See Figures 5, 6, and 7.

2. Record decay stage; see Table 2 and Figure 8.
3. Record cause of death Table 3.

Canopy Measurement

Densimeters are used at the center of each 100 m² plot to estimate the amount of canopy cover.

The spherical densimeter consists of a concave mirror with twenty-four ¼ inch squares engraved on the surface. Standing over the plot center, four densitometer readings are taken facing the four cardinal directions (N, E, S, and W). The densitometer is held level 12 - 18" in front of body at breast height, so the operator's head is not reflected back from the grid area. The 24 squares on the densitometer are divided into 96 dots, assuming equally spaced dots in each square of the grid. Readings are taken of the number of dots out of 96 that are covered by canopy (green leaves). If canopy openings are counted rather than canopy closure, subtract from 96 to obtain canopy coverage. The number of dots covered by canopy will be converted to percent canopy coverage (multiplied by 1.04) during the data summary process.

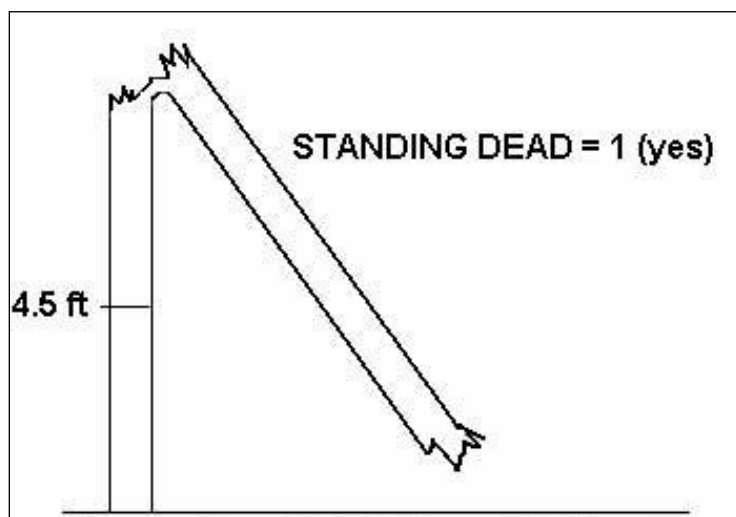
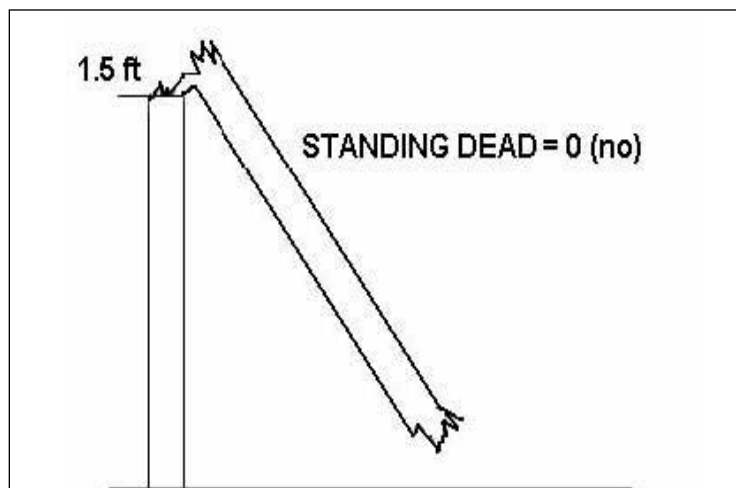


Figure 5. Example of a standing dead tree with an intact bole at 1.4 m (4.5 ft).



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Figure 6. Example of a standing dead tree without an intact bole at 1.4 m (4.5 ft).

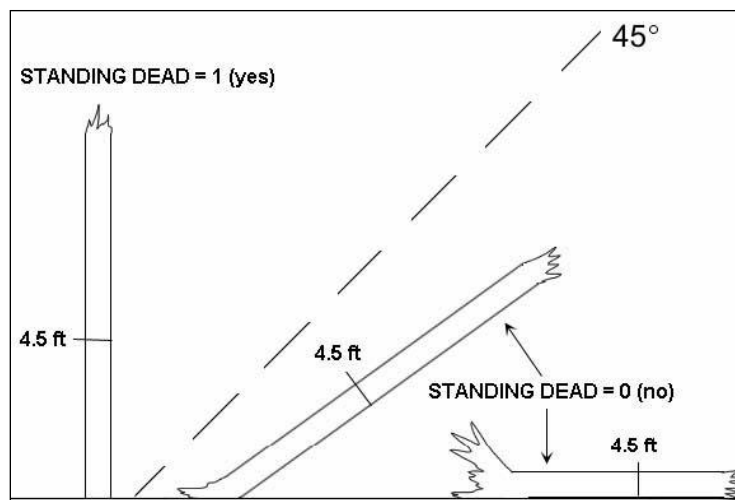


Figure 7. Determination of leaning standing dead trees. Leaning trees must be >45 degrees.

Table 2. Decay classification for standing dead trees. Characteristics are for Douglas-fir. Snags of other species may vary somewhat; use this table as a guide.

Stage	Limbs & Branches	Top	% Bark Remaining	Sapwood* Presence	Sapwood* Condition	Heartwood Condition
1	All present	Pointed	100	Intact	Sound, incipient decay, hard, original color	Sound, hard, original color
2	Few limbs, no fine branches	Broken	Variable ~80%	Sloughing	Advanced decay, fibrous, firm to soft, light brown	Sound at base, incipient decay in outer edge of upper bole, hard, light to red brown
3	Limb stubs	Broken	Variable ~60%	Sloughing	Fibrous, soft, light to reddish brown	Incipient decay at base, advanced decay throughout upper bole, fibrous, hard to firm, reddish brown
4	Few or no stubs	Broken	Variable ~40%	Sloughing	Cubical, soft, reddish to dark brown	Advanced decay at base, sloughing from upper bole, fibrous to cubical, soft, dark reddish brown
5	None	Broken	Less than 40%	Gone	Gone	Sloughing, cubical, soft, dark brown, OR fibrous, very soft, dark reddish brown, encased in hardened shell

*The outermost, lighter colored wood of a tree bole.

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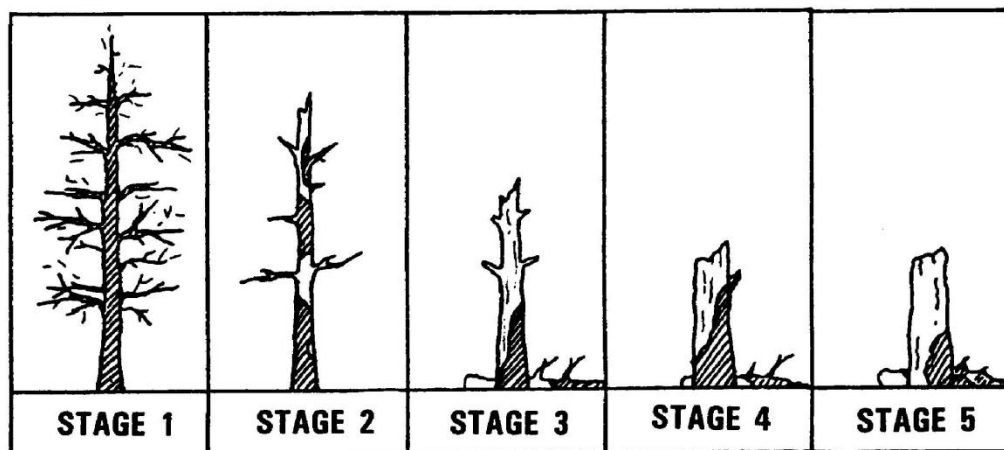


Figure 8. Decay stages for Douglas Fir. Others species may vary somewhat; use this as a guide.

Table 3. Causes of death for trees.

Cause of Death
Insect
Disease
Fire
Animal
Weather
Vegetation (suppression, competition, vines)
Unknown/not sure/other- includes death from human activity not related to silviculture or land clearing activity (accidental, random, etc.)

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Figure 9. Live and dead tree sampling datasheet.

Literature Cited

Cruz, M. G., M. E. Alexander, and R. H. Wakimoto. 2003. Assessing canopy fuel stratum characteristics in crown fire prone fuel types of western North America. *International Journal of Wildland Fire* **12**:39-50.